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CHEMICAL COMPOSITION, SENSORY QUALITY AND LEGISLATIVE COMPLIANCE OF MEADS EVALUATED IN A NATIONAL COMPETITION

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ABSTRACT

Mead is a traditional fermented beverage that has recently experienced renewed growth accompanied by increasing stylistic diversity. This diversification has raised questions regarding quality assessment and the relevance of existing analytical and legislative criteria. The aim of this study was to evaluate the chemical composition and sensory quality of meads submitted to a national competition and to analyse relationships among mead class, production attributes, legislative compliance, and sensory outcomes.
A total of 79 mead samples representing three classes (traditional mead, melomel, and metheglin) were analysed for selected physicochemical parameters and evaluated by a professional sensory panel. Compliance with Slovak legislative requirements was assessed, and differences among mead classes, honey types, and production methods were examined using non-parametric statistical tests. Multivariate analysis using principal component analysis (PCA) was applied to explore relationships between chemical parameters and sensory scores.
Significant differences among mead classes were observed only for volatile acidity ($p = 0.026$). No significant differences were found for alcohol content, residual sugars, or sensory scores. More than one third of samples failed to meet at least one legislative limit, most frequently due to the minimum alcohol content requirement; however, sensory scores of non-compliant and compliant samples did not differ significantly ($p = 0.919$). PCA indicated that sensory score was not strongly associated with individual physicochemical parameters. The results indicated that sensory quality of mead was not strictly determined by compliance with individual physicochemical limits, and the frequent non-compliance related to minimum alcohol content suggests that this legislative threshold may not fully reflect sensory-defined quality of mead.

Keywords: mead, honey wine, sensory evaluation, fermented beverages

INTRODUCTION

Mead is one of the oldest fermented beverages, produced by fermentation of diluted honey. In recent decades, mead production has experienced renewed interest, accompanied by increasing stylistic diversification including traditional meads ("show meads" containing only honey, water, and yeast), fruit meads (melomels), and spiced or herbal meads (metheglins). This diversification has led to substantial variability in technological approaches and product characteristics (**Webster *et al*., 2025**). Honey must differs from grape must in several important aspects, particularly in its low nitrogen content and different sugar composition, which can affect fermentation dynamics and formation of by-products (**Queiroz *et al*., 2024**; **Medina and Medina, 2025**; **Iglesias *et al*., 2014**).
Standard physicochemical parameters, including alcohol content, residual sugars, volatile acidity, sulphur dioxide, and extract, are commonly used to characterise mead composition and are embedded in national legislative frameworks, where mead is defined as a specific category of fermented beverages with prescribed analytical limits (**Ministry of Agriculture and Rural Development of the Slovak Republic, 2014**). Although physicochemical parameters are commonly used for quality control and legislative classification, sensory quality of mead is determined by complex interactions among chemical composition, fermentation-derived compounds and flavour balance, and therefore may not be fully predicted by routine analytical parameters alone.
Several studies have demonstrated that sweetness level plays a major role in mead acceptability, while ethanol content within typical ranges has a comparatively limited effect on sensory preference (**Gomes *et al*., 2015**). In contrast, excessive fermentation-derived defects, such as high volatile acidity, are generally associated with reduced sensory quality (**Pereira *et al*., 2019**). Contemporary consumer research further indicates that emotional responses, flavour balance, and perceived naturalness strongly influence attitudes toward mead (**Gorman *et al*., 2024**).
Sensory competitions provide a relevant framework for evaluating mead quality under standardised conditions, combining professional sensory assessment with laboratory analysis of submitted samples. In Slovakia, the national competition “Medovinka roka” (“Mead of the Year”) provides a platform for systematic sensory evaluation of meads under controlled conditions. In addition to national competitions, several international mead competitions are organised worldwide, including the Mead Madness Cup, the Mazer Cup or the Copa del Hidromiel.
Despite the growing body of literature on mead production and chemistry, systematic evaluations linking analytical composition, legislative compliance, and sensory evaluation outcomes across larger sets of commercial meads remain limited (**Starowicz and Granvogl, 2020**; **Webster *et al*., 2025**; **Kružík *et al*., 2022**).
Therefore, the aim of this study was to evaluate the chemical composition and sensory quality of meads assessed in a national competition, to compare different mead classes and production attributes, and to analyse the relationship between legislative compliance and sensory evaluation.

MATERIALS AND METHODS

Mead samples

A total of 79 mead samples were evaluated within a national mead competition “Medovinka roka” held in Slovakia in 2022. The samples were submitted by individual producers and represented a broad range of production styles, raw materials, and maturation periods. All samples were anonymised prior to evaluation to ensure impartial sensory assessment.
Based on producer declarations and competition classification rules, meads were grouped into three main mead classes: traditional mead, fruit mead (melomel), and spiced or herbal mead (metheglin). In addition, samples were categorised according to declared honey type (monofloral or mixed honey) and production type (boiled or cold processing).

Chemical analyses

All mead samples were subjected to laboratory analysis of selected physicochemical parameters in an accredited laboratory at the State Veterinary and Food Institute in Dolny Kubín, Slovakia. The analysed parameters included alcohol content (% v/v), volatile acidity (g/L), total sugar content (g/L), total and free sulphur dioxide (mg/L), non-sugar extract (g/L), total extract (g/L), and relative density at 20 °C. Analytical determinations were performed using standard methods commonly applied in fermented beverage analysis.

Compliance with Slovak legislative requirements for mead was assessed according to Decree No. 30/2014 Coll. (**Ministry of Agriculture and Rural Development of the Slovak Republic, 2014**). The evaluated limits included minimum alcohol content (≥11 % v/v), maximum volatile acidity (≤1.6 g/L), minimum total sugars (≥ 40 g/L) and minimum non-sugar extract (≥19 g/L). Total sulphur dioxide content was evaluated using a reference limit of ≤200 mg/L commonly applied in national quality control practice for wine and related fermented beverages.

Sensory evaluation

Mead evaluation was performed using a 100-point scoring system approved by the OIV (International Organisation of Vine and Wine) and the International Union of Oenologists. Samples were evaluated anonymously under controlled tasting conditions. All tasters were experienced evaluators regularly participating in national wine and mead competitions. Prior to the official assessment, a brief calibration discussion was conducted to harmonise scoring criteria and ensure consistency among commissions. Each sample was evaluated independently by members of a single commission composed of three tasters, and the final sensory score represented the arithmetic mean of individual scores. The use of multiple commissions reflects standard competition practice and aims to reduce individual evaluator bias. To evaluate inter-panel consistency, differences in mean sensory scores among commissions were tested using the Kruskal–Wallis test. No statistically significant differences among commissions were observed ($p > 0.05$), indicating acceptable agreement among sensory panels. The final sensory score for each sample was calculated as the mean value of individual scores within each commission.

Each sample was assigned a final sensory score expressed in points. Based on the obtained scores, samples were awarded gold, silver, or bronze medals, or received no award according to predefined score thresholds. The professional mead tasting took place on March 18, 2022 with the participation of 9 tasters, from whom 3 commissions were formed under the leadership of the competition guarantor. Award categories were assigned according to predefined score thresholds within a 100-point sensory evaluation system. Gold (GM), silver (SM) and bronze (BM) medals corresponded to score ranges of 88–100, 85–87.99 and 80–84.99 points, respectively. Samples scoring less than 80 points were classified as non-awarded. Finally, the title "Champion of the Exhibition" was awarded to the top three samples in the traditional mead category and to the top three samples in the flavoured mead category (metheglin and melomel).

Data processing and statistical analysis

Descriptive statistics were calculated for all chemical and sensory parameters. Differences among mead classes (traditional mead, melomel, and metheglin) were evaluated using the Kruskal–Wallis test. Normality of data distribution was evaluated using the Shapiro–Wilk test and homogeneity of variances using Levene's test. As several variables deviated from normal distribution and group sizes were unequal, non-parametric tests were applied. Differences among mead classes were evaluated using the Kruskal–Wallis test, while differences between compliant and non-compliant samples were assessed using the Mann–Whitney U test. Relationships between selected chemical parameters and sensory scores were analysed using Spearman rank correlation.

Declared honey type (monofloral vs mixed) and production type (boiled vs cold processing) were analysed as categorical factors. Due to the declarative nature of these variables, results were interpreted cautiously and considered primarily descriptive.

Statistical analyses were performed using Python-based statistical tools. Differences were considered statistically significant at $p < 0.05$. Complete analytical and sensory data were used for statistical analysis and are available under request.

In addition to univariate statistical analysis, multivariate analysis was performed using principal component analysis (PCA) to explore relationships among physicochemical parameters and sensory scores. The analysis included alcohol content, volatile acidity, total sugars, total and free sulphur dioxide, non-sugar extract, total extract, density and sensory score. Prior to PCA, data were standardised using z-score transformation to eliminate the effect of different measurement units. PCA results were visualised using score plots, and component loadings were used to interpret relationships among variables.

RESULTS

Overall chemical and sensory characteristics of meads

A total of 79 mead samples were analysed, representing three main mead classes: traditional mead, fruit mead (melomel), and spiced or herbal mead (metheglin). The analysed samples showed considerable variability in both chemical composition and sensory quality.

Alcohol content ranged from 6.4 to 16.2 % v/v, volatile acidity from 0.68 to 3.68 g/L, total sugar content from 48.6 to 304.4 g/L, and non-sugar extract from 18.1 to 65.2 g/L. Sensory scores ranged from 69.0 to 93.67 points, reflecting a wide diversity of mead styles and production approaches represented in the competition. Descriptive statistics are summarised in Table 1.

Table 1 Descriptive statistics of selected physicochemical parameters and sensory scores of analysed meads (n = 79)

	Alcohol (% v/v)	Volatile acidity (g/L)	Total sugars (g/L)	Total SO_2 (mg/L)	Free SO_2 (mg/L)	Non sugar extract (g/L)	Total extract (g/L)	Density at 20°C	Sensory score (points)
count	79	79	79	79	79	79	79	79	79
mean	11.56	1.3	138.03	71.67	6.88	35.59	173.51	1.05	83.83
SD	1.96	0.43	58.98	47.33	4.82	10.36	59.4	0.02	5.72
min	6.4	0.68	48.6	15	2	18.1	74.7	1.01	69
25 %	10.3	1.07	98	43.5	4	28.6	134.5	1.04	79.67
50 %	11.6	1.2	129.2	54	5	34.4	163.8	1.05	83.67
75 %	13	1.41	164.05	77.5	7.75	40.4	201.05	1.06	89
max	16.2	3.68	304.4	318	28	65.2	336.6	1.12	93.67

Note: n: number of samples; SO_2: sulphur dioxide; SD: standard deviation; % v/v, volume/volume. Volatile acidity is expressed as g/L acetic acid.

Differences among mead classes

Differences among the three mead classes (traditional mead, melomel, and metheglin) were evaluated using non-parametric statistical tests.

A statistically significant difference among mead classes was detected only for volatile acidity (Kruskal–Wallis test, $p = 0.026$) visualised in Figure 1. The magnitude of this effect was small to moderate, indicating limited but detectable class-related variation. Melomels exhibited the lowest median volatile acidity values (1.02 g/L), followed by traditional meads (1.23 g/L), while the highest median values were observed in metheglins (1.31 g/L).

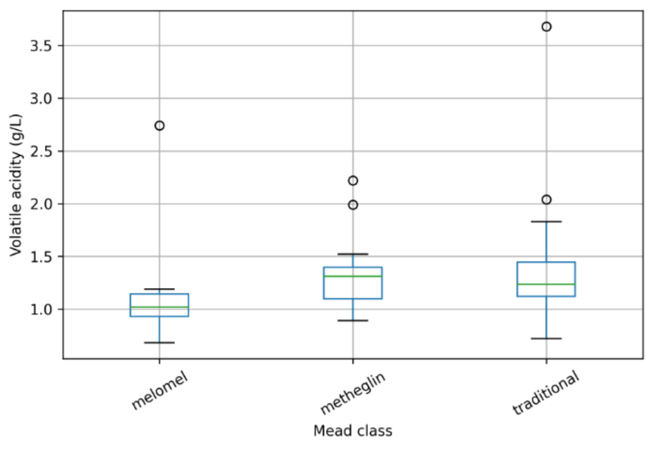

Figure 1 Distribution of volatile acidity (g/L acetic acid) among three mead classes (melomel, metheglin and traditional mead)

Note: Differences among groups were evaluated using the Kruskal–Wallis test. Boxes represent interquartile ranges, horizontal lines indicate medians, whiskers denote minimum and maximum values, and individual points represent outliers.

In contrast, no statistically significant differences among mead classes were observed for alcohol content ($p = 0.430$), total sugar content ($p = 0.690$), or sensory score ($p = 0.167$).

Differences among mead classes are shown in Table 2. These results indicate that, although mead classes differ in their acidity profiles, overall sweetness level, ethanol concentration, and sensory performance were comparable across styles.

Table 2 Physicochemical parameters and sensory score according to mead class (median and interquartile range)

Mead class	n	Alcohol (% v/v)	Volatile acidity (g/L)	Total sugars (g/L)	Sensory score
Melomel	11	12.1 (11.4–13.0)	1.02 (0.93–1.14)	117.1 (74.15–159.35)	84.67 (81.17–88.50)
Metheglin	26	11.9 (10.38–12.95)	1.31 (1.10–1.40)	131.7 (112.92–147.05)	86.17 (82.67–89.25)
Traditional	42	11.35 (9.57–12.92)	1.23 (1.12–1.44)	132.0 (97.90–173.60)	81.16 (79.00–86.92)

Note: Values are presented as median (interquartile range). n – number of samples.

Legislative compliance and sensory evaluation

Compliance with Slovak legislative requirements was assessed based on the applied legislative reference limits described in Section "Chemical analyses". Samples failing to meet at least one of these criteria were classified as non-compliant. Based on these criteria, 50 samples (63.3 %) were classified as compliant, while 29 samples (36.7 %) failed to meet at least one legislative limit, mainly regarding minimal alcohol limit (26 samples). Comparison of sensory scores between compliant and non-compliant samples revealed no statistically significant difference (Mann–Whitney U test, $p = 0.919$). The corresponding effect size was negligible ($r < 0.1$), indicating absence of practically relevant difference between groups.

Mean sensory scores were 83.85 ± 5.28 points for compliant meads and 83.78 ± 6.52 points for non-compliant meads, indicating nearly identical sensory evaluation outcomes. This suggests that deviation from one or more legislative physicochemical limits did not correspond to reduced sensory quality as assessed by the professional tasting panel. Notably, all three samples awarded the title "Champion of the Exhibition" in the traditional mead category did not meet the applied minimum alcohol content requirement (≥11 % v/v).

Sensory scores of compliant and non-compliant samples are compared in Table 3 and Figure 2.

Table 3 Sensory scores of compliant and non-compliant meads

Compliance	n	Mean ± SD	Median	IQR
Compliant	50	83.85 ± 5.28	83.5	79.75–88.67
Non-compliant	29	83.78 ± 6.52	85.33	79–89.33

Note: n – number of samples; SD – standard deviation; IQR – interquartile range. Differences between groups were not statistically significant (Mann–Whitney U test, $p = 0.919$).

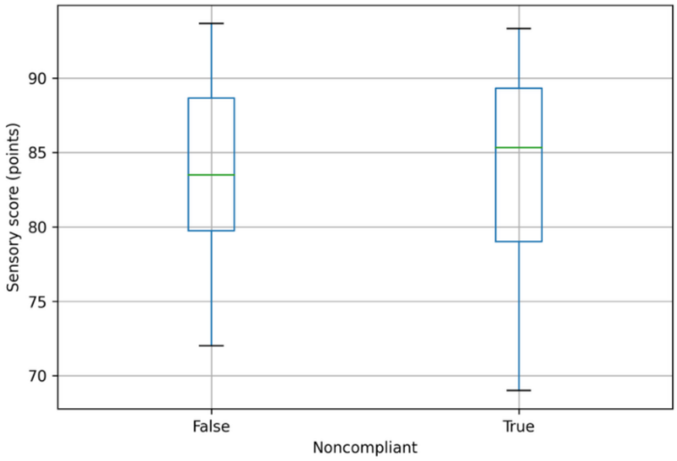

Figure 2 Comparison of sensory scores between compliant and non-compliant meads according to Slovak legislative reference limits

Note: Group differences were assessed using the Mann–Whitney U test. Boxes represent interquartile ranges, horizontal lines indicate medians, and whiskers denote minimum and maximum values.

Influence of honey type and production type

Meads were further categorised according to declared honey type (monofloral or mixed honey) and production type (boiled or cold processing). Statistical analysis did not reveal significant differences in alcohol content, volatile acidity, total sugar content, or sensory score between monofloral and mixed-honey meads ($p > 0.05$ for all parameters).

Similarly, no statistically significant differences were observed between boiled and cold-processed meads for any of the evaluated chemical parameters or sensory scores ($p > 0.05$). Given the declarative nature of these classifications and the absence of analytical verification, these results are interpreted as descriptive rather than definitive.

Multivariate analysis

Principal component analysis (PCA) was performed to explore relationships among physicochemical parameters and sensory scores (Figure 3). The first two principal components (PC1 and PC2) explained 56.8 % of the total variability in the dataset (PC1: 38.4 %, PC2: 18.4 %). PC1 was mainly associated with extract-related parameters, total sugars and density, while PC2 was primarily associated with volatile acidity and sulphur dioxide parameters. Sensory score showed only moderate association with the main chemical variables, indicating that sensory quality was not strongly determined by any single physicochemical parameter but rather by the overall balance of composition. This suggests that sensory quality was influenced by multiple factors rather than by individual physicochemical parameters.

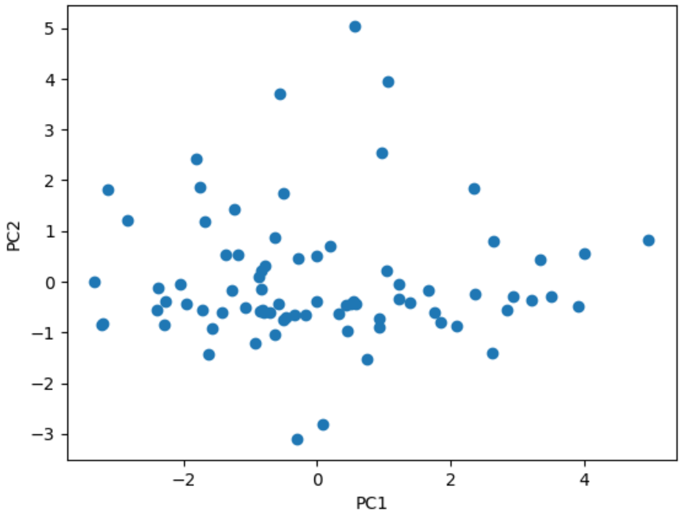

Figure 3 Principal component analysis (PCA) of physicochemical parameters and sensory score of analysed meads

The PCA score plot showed substantial overlap among mead classes as well as between compliant and non-compliant samples, confirming results of univariate analysis that basic physicochemical parameters alone do not clearly differentiate mead styles nor predict sensory evaluation outcomes.

DISCUSSION

The present study provides a systematic evaluation of the chemical composition and sensory quality of meads assessed in a national competition, with particular emphasis on differences among mead classes, production attributes, and legislative compliance. The results offer several relevant insights into factors influencing mead quality as perceived by trained sensory panels and complement existing knowledge on mead chemistry and sensory evaluation.

Differences among mead classes

Among the evaluated mead classes (traditional mead, melomel, and metheglin), a statistically significant difference was observed only for volatile acidity. Fruit meads (melomels) exhibited lower median values of volatile acidity compared to traditional meads and metheglins. This observation may be attributed to differences in raw material composition and fermentation dynamics, as fruit additions can affect yeast metabolism, organic acid balance, and buffering capacity during fermentation (**Iglesias *et al.*, 2014; Queiroz *et al.*, 2024**).

Volatile acidity in mead primarily reflects acetic acid formation during fermentation and possible post-fermentation microbial activity (**Medina and**

Medina, 2025). Elevated volatile acidity may result from yeast stress under nutrient-limited conditions typical for honey must, excessive oxygen exposure during fermentation, or secondary contamination by acetic acid bacteria (**Iglesias *et al.*, 2014; Medina and Medina, 2025**). Fruit additions in melomels may modify fermentation kinetics by contributing additional organic acids, micronutrients, and buffering capacity, potentially stabilising fermentation and limiting excessive acetic acid formation (**Queiroz *et al.*, 2024**). Moreover, fruit-derived acids may partially mask perceptible acetic sharpness, thereby influencing both analytical expression and sensory perception of acidity (**Pereira *et al.*, 2019; Starowicz and Granvogl, 2020**).

In contrast, no significant differences among mead classes were detected for alcohol content, total sugar content, or sensory score. This indicates that despite stylistic differences, producers were able to achieve comparable levels of sweetness, ethanol concentration, and overall sensory acceptability across mead classes. Similar conclusions were reported by **Kružík *et al.* (2022)**, who observed overlapping ranges of basic chemical parameters among different categories of honey wines and dessert meads. These findings support the view that basic physicochemical parameters alone may be insufficient to define mead style or sensory quality, and that aroma composition and flavour balance play a more decisive role (**Webster *et al*., 2025)**. Similar observations have been reported in studies addressing honey wines and fruit-based fermented beverages, where basic parameters such as ethanol or residual sugars showed limited discriminative power compared to volatile compound profiles and aroma-active molecules (**Pereira *et al.*, 2019; Starowicz and Granvogl, 2020**).

The absence of statistically significant differences in alcohol content, total sugars, and overall sensory score among mead classes suggests partial convergence of basic physicochemical characteristics across stylistic categories. From a technological perspective, this may indicate that contemporary producers, even when working with different formulations (fruit or spices), aim to achieve broadly similar sweetness and ethanol levels in order to meet consumer expectations.

These findings highlight a potential limitation of routine physicochemical parameters for discriminating stylistic diversity in meads. Basic analytical indicators may not capture differences in volatile composition, phenolic profile, aroma complexity, or flavour integration, which are likely more decisive for sensory differentiation among mead styles. Previous studies emphasise the importance of detailed aroma profiling and volatile compound analysis in explaining sensory variability in meads (**Pereira *et al.*, 2019; Reitenbach *et al.*, 2025**). Therefore, the lack of significant differences observed in the present study should not be interpreted as stylistic homogeneity, but rather as an indication that more advanced analytical approaches would be required to fully characterise stylistic distinctions. Recent studies applying multivariate modelling and machine learning approaches to mead evaluation further demonstrate that relationships between chemical composition and sensory quality are multidimensional and cannot be fully captured using isolated analytical indicators (**Przybył *et al.*, 2025**).

Sensory quality in relation to legislative compliance

One of the most relevant findings of this study concerns the relationship between legislative compliance and sensory evaluation. More than one third of the analysed meads failed to meet at least one Slovak legislative physicochemical requirement. Nevertheless, sensory scores of non-compliant meads did not differ significantly from those of compliant samples.

This result indicates that deviations from current regulatory limits did not translate into inferior sensory quality when assessed by trained panellists under competition conditions. In particular, samples exceeding limits for volatile acidity or failing to meet minimum thresholds for alcohol content or non-sugar extract were frequently evaluated as sensorially acceptable. Previous studies have shown that sensory acceptability of mead is primarily driven by sweetness balance and flavour harmony rather than strict adherence to individual analytical parameters (**Gomes *et al*., 2015; Gorman *et al*., 2024**). In broader research on fermented beverages, discrepancies between regulatory analytical limits and perceived sensory quality have also been described, particularly in artisanal products where stylistic expression may deviate from standardised production models (**Webster *et al.*, 2025; Starowicz and Granvogl, 2020**).

From a technological perspective, moderate deviations from fixed analytical thresholds may occur without negative sensory consequences, especially in artisanal or non-standard mead styles. Similar considerations were highlighted by **Webster *et al*. (2025)**, who emphasised that analytical limits do not always correlate with perceived quality and should be interpreted in the context of product style and sensory profile. This finding challenges the assumption that compliance with fixed analytical limits necessarily reflects product quality as perceived by trained sensory panels.

Influence of honey type and production method

Neither declared honey type (monofloral vs mixed honey) nor production type (boiled vs cold processing) showed a statistically significant influence on the evaluated chemical parameters or sensory scores. These results are consistent with findings reported by **Vidrih and Hribar (2007)**, who observed that technological processing affected selected physicochemical attributes but did not necessarily translate into clear differences in sensory acceptance.

Several authors have emphasised that botanical origin of honey and thermal processing primarily influence volatile compounds, phenolic composition, and colour rather than basic parameters such as alcohol content or residual sugars (**Starowicz and Granvogl, 2020; Reitenbach *et al*., 2025**). Advanced chromatographic analyses have demonstrated that volatile composition varies significantly with botanical origin and technological processing, often exerting stronger influence on perceived sensory differentiation than routine physicochemical parameters (**Kawa-Rygielska *et al.*, 2019**). Recent bibliometric analyses further confirm that contemporary mead research increasingly focuses on aroma-active compounds and advanced profiling techniques, rather than solely on routine physicochemical parameters (**Reitenbach *et al.*, 2025**). This shift suggests that standard analytical variables may capture only part of the technological and sensory complexity of meads. The absence of significant effects in the present study may therefore be partly explained by the focus on standard physicochemical parameters rather than detailed aroma profiling.

The lack of analytical verification of declared honey type and production method represents an additional limitation, as variability in technological practices within each category likely contributed to overlapping parameter ranges.

Implications for mead quality assessment and regulation

Taken together, the results highlight a potential discrepancy between regulatory compliance and sensory-defined quality of mead. While legislative limits play an important role in ensuring product safety and minimum quality standards, their relevance for sensory evaluation may require further discussion, particularly for artisanal and stylistically diverse mead products.

At the European Union level, there is currently no harmonised analytical definition of mead comparable to that existing for wine within the common market organisation framework. Similar diversity in regulatory approaches has been noted in broader reviews of traditional fermented beverages, where mead is often grouped within heterogeneous legislative categories across different jurisdictions (**Medina and Medina, 2025**). Mead is generally regulated within broader categories of fermented beverages at the national level, which may result in differences in analytical thresholds among member states. Consequently, legislative limits applied in Slovakia represent one national regulatory model rather than a universally harmonised European standard. This regulatory heterogeneity should be taken into account when interpreting physicochemical compliance in an international context.

Sensory competitions supported by chemical analyses may represent a valuable complementary approach to mead quality assessment, capturing attributes not fully reflected by fixed analytical limits. Similar arguments have been raised in broader reviews of mead quality evaluation, which emphasise the need to integrate sensory evidence and analytical data when assessing overall product quality (**Starowicz and Granvogl, 2020; Webster *et al*., 2025**).

The observed lack of association between minimum alcohol content compliance and sensory quality highlights the complexity of aligning fixed analytical thresholds with sensory-defined quality. In this context, the results may contribute to further discussion on whether current minimum alcohol requirements adequately reflect the stylistic diversity of contemporary mead production. Historically, legislative limits were established at a time when mead production in Central Europe was dominated primarily by traditional and spiced meads with higher residual sugar and higher alcohol content. However, contemporary mead production has become more diverse, partly influenced by international mead-making practices and the development of new market segments, such as lower-alcohol "session meads", which are designed for easier consumption and typically contain approximately 8–10 % (v/v) alcohol (**Webster *et al.*, 2025**). This stylistic diversification may partly explain why some otherwise sensorially acceptable meads do not meet minimum national alcohol requirements (≥11 % v/v). These findings do not imply that regulatory standards should be modified without broader evidence. Rather, they indicate that sensory outcomes may represent a complementary dimension of quality assessment, particularly in stylistically diverse artisanal products. Broader datasets including commercial products and additional analytical parameters would be required before drawing conclusions at the regulatory level.

Practical implications for mead producers

From a practical perspective, the results of this study suggest that mead producers should focus primarily on fermentation management, sugar balance and control of volatile acidity rather than strictly targeting individual legislative limits. The absence of a relationship between legislative compliance and sensory score indicates that sensory-defined quality depends more on overall balance and flavour integration than on isolated analytical parameters. Similar conclusions have been reported in previous studies, which emphasise that routine physicochemical parameters alone are not sufficient to explain sensory differences among meads and that aroma-active compounds and flavour balance play a major role in sensory perception (**Pereira et al., 2019**; **Starowicz and Granvogl, 2020**). Consumer research further indicates that sweetness balance is one of the main drivers of mead acceptability, while ethanol content within typical ranges has a comparatively smaller effect on sensory preference (**Gomes et al., 2015**). Recent reviews therefore highlight that mead quality should be evaluated using a combination of chemical and sensory approaches rather than relying solely on individual analytical limits (**Webster et al., 2025**).

Limitations of the study

Several limitations of this study should be acknowledged. Competition samples may represent products intentionally prepared for sensory evaluation under specific conditions and may therefore not reflect the full variability of commercially distributed meads. Information on honey type and production method was declarative and not analytically verified. In addition, the study focused on standard physicochemical parameters and did not include volatile compound analysis or phenolic profiling, which are known to have a strong impact on sensory perception (**Pereira *et al*., 2019; Reitenbach *et al*., 2025**). Incorporating chromatographic profiling of volatile fractions or multivariate modelling approaches could provide additional explanatory power in future investigations.

CONCLUSIONS

A key finding of this study is that non-compliance with selected Slovak legislative physicochemical limits was not associated with lower sensory quality. Meads that failed to meet one or more regulatory thresholds achieved sensory scores comparable to those of compliant samples, suggesting that current legislative criteria may not always directly correspond to sensory-defined quality.
Declared honey type and production method showed no statistically significant influence on chemical composition or sensory evaluation. Overall, the results indicate that balanced formulation and appropriate fermentation management are more critical determinants of sensory quality than isolated analytical parameters or strict adherence to fixed legislative thresholds.
The findings support integration of sensory evaluation with chemical analysis in mead quality assessment and provide objective evidence contributing to discussion on the suitability of existing analytical and regulatory frameworks for diverse mead styles.

Data Availability Statement: The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request, taking into account the anonymised nature of competition samples.

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